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SANITARY COMMISSION.

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REPORT

OF A

COMMITTEE APPOINTED BY THE SANITARY COMMISSION

TO PREPARE A PAPER ON THE

VALUE OF VACCINATION IN ARMIES.

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Com { From. B. Smith
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THE attention of the Sanitary Commission has been called to the fact that most of our Army Surgeons now in the field, are unavoidably deprived of many facilities they have heretofore enjoyed for the consultation of standard medical authorities. It is obviously impossible to place within their reach anything that can be termed a medical library. The only remedy seems to be the preparation and distribution, among the medical officers of the army, of a series of brief essays, or hand-books, embodying, in a condensed form, the conclusions of the highest medical authorities in regard to those medical and surgical questions which are likely to present themselves to surgeons in the field, on the largest scale, and which are, therefore, of chief practical importance.

The Commission has assigned the duty of preparing papers on several subjects of this nature to certain of its associate members, in our principal cities, belonging to the medical profession.

The following paper on the *Value of Vaccination in Armies*, belongs to this series, and is respectfully recommended by the Commission to the attention of medical officers.

FRED. LAW OLMSTED,

Secretary.

WASHINGTON, Dec. 1861.

REPORT.

IN view of the possible occurrence of smallpox as an epidemic in our camps, and of the well established fact of its great contagiousness, even under the most favorable circumstances, the question of protection against its ravages commended itself, with great propriety, to the "Sanitary Commission." At their request the undersigned have prepared a short digest of the more recent authorities upon the subject of protection, which, with the sanction of the "Commission," they respectfully submit to the medical officers in the service of the government. It is unnecessary to enter into any history of vaccination; that, it is presumed, is familiar to all to whom this paper is addressed; but the question of its protective influence and the various circumstances modifying it, together with the results of revaccination in large bodies of men, may perhaps be profitably discussed. The fact cannot be concealed that a feeling of doubt has arisen in the minds of some (chiefly non-professional persons it is true), in regard to the efficacy and protective power of vaccination, together with an ill-defined fear that some malign influence may through its agency be introduced into the bodies of those receiving it. To such the strongest argument that can be presented, and the unanswerable one, is that which, in the words of Jenner, "is engraved with the point of the lancet."

It may not be out of place, however, to recall the analogy, if not similarity, of a disease which prevails among several of the lower animals and in man, and its communicability and protective influence from one to the other. The "grease" in the

horse and the vaccine disease or cowpox are believed to be the same disease with smallpox in man. And as one attack of smallpox is known to be an almost certain protection against subsequent attacks, so may the artificial production of a modified smallpox in man present an immunity from further visitations. "It is well known," says Mr. A. B. Steele,* "that Jenner was strongly impressed with the conviction that cowpox is neither more nor less than a mild form of smallpox, and this prediction has been completely verified by subsequent observations." In the report of the Vaccination Committee of the British Medical Association† the following conclusions, drawn from information derived from various sources, may be found:—

First. That it has been proved that cattle, in many ages and in different countries, have been affected with smallpox.

Secondly. That the disease among the inferior animals has simultaneously existed with the smallpox in man, and pursued its victims through every country of the globe.

Thirdly. That it appeared among cattle in England in 1745, and again in 1770, and continued its ravages up to 1800; and that the local remains of this epizootic occasionally still show themselves with considerable severity.

Fourthly. When the disease appears among the inferior animals in a malignant form, it produces, by inoculation, a disease of a similar severity in man.

Fifthly. That as man has received this affection from the cow, so likewise has the cow received it from man.

Sixthly. The direct inoculation of the cow with human smallpox has produced a mild and mitigated disease, and that such a disease reproduced by inoculation in man, accords entirely in its character, its progress, and its protective influence, with the variola vaccinia as described by Dr. Jenner, thus irresistibly proving his fundamental proposition, that cowpox and small-

* Liverpool Med.-Chir. Jour., July, 1858.

† Trans., vol. viii.

pox are not bona fide dissimilar, but identical, and that the vaccine disease is not the preventive of smallpox, but smallpox itself, the virulent and contagious disease being a malignant variety.*

The late Samuel Forry, M. D., of New York, formerly of the U. S. Army, remarks: "That the opinion has received a very remarkable corroboration in the recent experiments of Mr. Ceely, of England, which seem to prove that not only may the cow be inoculated with variolous matter, but it may thus be converted into vaccine. Two experiments made by Dr. Thiele, of Kasan, in Russia, appear to confirm the same result. In 1836 he inoculated some cows on the udder with the matter of smallpox, which produced vesicles bearing all the characters of the true vaccine vesicle in those animals. During seventy-five successive transmissions in the human subject of the vaccine virus thus produced, it appeared always to retain its normal character. In 1838 M. Thiele repeated this experiment with the same success."†

The subject of Vaccination, whether in civil or in military life, may be considered under three heads: 1. *Does vaccination afford positive protection to those exposed to the variolous contagion?* 2d. *Is that protection permanent, or is it modified by any circumstances?* 3d. *If not permanent, is revaccination a preventive of the disease?*

* Strong evidence in support of this proposition is found in the fact that cattle who were put to graze in a field where the bedclothes of smallpox patients were exposed to the air, contracted the disease, and presented not only the characteristic eruption, but well-marked constitutional symptoms. (Wilson on *Diseases of the Skin*, 4th Am. ed., p. 453.) Dr. Waterhouse, of Cambridge, Mass., in a letter to Dr. Jenner, details the communication of the disease to cows by the hands of milkers who were suffering from variola; and Dr. Sonderland, of Bremen, communicated the smallpox contagion to cows by covering them with sheets between which persons fatally affected with smallpox had lain.

† Boylston Prize Essay.

1. *Does vaccination afford positive protection to those exposed to variolous contagion?*

In considering this first question we are struck with the vast amount of evidence which has been accumulated in its favor. It finds no parallel in any other scientific investigation. The committee have endeavored to select such only as seemed most conclusive, and have drawn largely from both domestic and foreign sources.

The late Dr. S. Forry, in the Boylston Prize Essay, 1844, says that, "as respects the protecting power of vaccination against smallpox, it is, *when perfect*, as complete a protection as any other prophylactic known to man."

The report of the committee of the Medical Society of Philadelphia, by Drs. C. J. Coxe, Condie, and C. D. Meigs, contains the remarkable fact that during the prevalence of a most malignant and fatal smallpox in 1827, but *one* well ascertained death from that disease, among 80,000 vaccinated, came to the knowledge of the committee.

Drs. J. Bell and J. K. Mitchell* report that of 248 cases of variola and varioloid treated at the Smallpox Hospital, 155 were unprotected, of whom 85 died; 64 were vaccinated, of whom but a single one died; 9 were inoculated, of whom 3 died; and of the 13 whose condition was unknown, none died.†

In an epidemic which prevailed from 1825 to 1827, in Copenhagen, of those who had been vaccinated 428 were attacked; and in 26 of these all the symptoms of genuine variola were evinced, but only two of them died.‡

In Holstein, from 1801 to 1822, 234,959 were subjected to vaccination, and only two individuals even two years subsequent to this, had during all that time been affected with smallpox. In the kingdom of Denmark, during the same period,

* N. A. Med. and Surg. Journ., vol. ii. 1826.

† Bell and Stokes' Practice.

‡ Forry.

only one individual among 447,605 vaccinated had been attacked by modified variola.

Dr. G. B. Wood* says that "vaccination affords the best attainable security to life, greater even than that accruing from a previous attack of smallpox; that, with due care, it will serve as an effectual safeguard in individual cases almost without an exception. In the course of my practice, though I have seen much of the disease, I have lost but one patient after vaccination, and in that instance death occurred, not from the violence of the varioloid disease, which was mild, but from the super-vention of inflammation of the brain, consequent on the peculiar state of the patient's constitution at the time. Thus it appears that if the protection afforded by vaccination is not perfect, it is superior to any other."

Dr. John Davy, Inspector-General of Army Hospitals,† presents some valuable statistics in relation to the comparative mortality of the native population of Malta and the military, among whom smallpox had been introduced by H. M. S. Asia, by which it appears that the mortality among those "not vaccinated" was 1 in 4.7; among those "supposed to have been vaccinated," 1 in 23.4; among those "well vaccinated," 1 in 15.6; and lastly, among those attacked a second time by smallpox, 1 in 10.8 The higher mortality among those supposed to have been vaccinated Dr. Davy explains by the supposition that the majority of the former may have belonged to the infantile age. "As regards the general effect of vaccination in its influence both as affording protection from smallpox to a considerable extent, and mitigating its severity when not preventing the attack, the facts given are clear and satisfactory. *It is a curious circumstance that the proportion of those who died after a second attack of smallpox was, as has been already pointed out,*

* Practice, vol. i. 410.

† Notes and Observations in the Ionian Islands and Malta, &c. Lond. 1841.

greater than in the instances of those who had the disease after vaccination." The comparative exemption of the British troops serving in Malta is another evidence of the protective influence of vaccination. Dr. Davy says further that "the native population (in Malta) in 1830 was estimated at 100,839 persons; amongst whom, it appears, from preceding returns, 1 in every 12.1 was attacked with the disease, and 1 in every 85 died; but amongst the military, including their wives and children, the proportion attacked was 1 in 188, and the mortality was only 1 in 682."

The petition of Mr. J. F. Marson in support of the "Vaccination Bill"* before the British Parliament, in 1856, after declaring that he "has been for upwards of twenty years the Resident Surgeon of the Smallpox and Vaccination Hospital, in London," states that the mortality from smallpox in the *unvaccinated*, of cases taken generally, is *thirty-five per cent.*, but of children under five years of age, it is *fifty per cent.*; and of those who recover, a great many suffer permanent disfigurement, some loss of sight, and others have their health greatly damaged.

The mortality, on the contrary, amongst the vaccinated, attacked by smallpox is *seven per cent.*, taken generally; but amongst those who may be characterized as the *badly vaccinated*, it is *fifteen per cent.* Amongst those, on the other hand, who may be considered to be *well vaccinated*, that is to say, who have four or more *good* vaccine cicatrices, the mortality is *less than one per cent.*

In the report of the "Smallpox and Vaccination Committee of the Epidemiological Society" of London, presented to the British Parliament, in 1853, is collected a mass of evidence abundantly sustaining the protective influence of vaccination.

As *results* are most desirable in a communication like the

* Lancet, Aug. 30, 1856.

present, the following statistics collected by the Society are presented.

1st. To prove the influence of vaccination in England. Out of every 1000 deaths in the half century from 1750 to 1800, there were of smallpox 96. Out of every 1000 deaths in the half century from 1800 to 1850, there were of smallpox 35.

2d. To prove the influence of vaccination on the Continent. In various German States sufficient evidence can be obtained to show that, before vaccination was used, out of every 1000 deaths there occurred from smallpox 66.5; after vaccination, 7.26.

3d. To prove that in countries where vaccination is most perfectly carried out, smallpox is least mortal.

(a.) In this country (England), where vaccination is voluntary, and frequently neglected, the deaths from all causes being 1000, the deaths from smallpox in the following towns are as follows:—

London, 16; Birmingham, 16.6; Leeds, 17.5; England and Wales, 21.9; Paisley, 18; Edinburgh, 19.1; Perth, 25; Glasgow, 36; Dublin, 25.66; Galway, 35; Limerick, 41; Connaught, 60; all Ireland, 49.

(b.) In other countries, where vaccination is more or less compulsory, the deaths from smallpox in the following towns are as follows:—

Westphalia, 6; Saxony, 8.33; Rhenish provinces, 3.75; Pomerania, 5.25; Lower Austria, 6; Bohemia, 2; Lombardy, 2; Venice, 2.2; Sweden, 2.7; Bavaria, 4.

By referring to the accompanying table prepared by Mr. Haile, and found in Mr. J. Simon's report,* the past and present ravages of the disease may be seen at a glance, and two series

* Papers relating to the History and Practice of Vaccination. Presented to both Houses of Parliament by command of Her Majesty. London, 1857.

of facts be noticed. "1st. How many persons in each million of population died annually of smallpox, *before* the use of vaccination; and, 2d. How many persons in each million of population have annually died of smallpox, *since* the use of vaccination." The author draws the conclusion, as the reader may also do, between the case of Sweden, in the twenty-eight years before vaccination, and forty years soon afterwards: "During the earlier period, there used to die of smallpox, out of each million of the Swedish population, 2050 victims annually; during the later period, out of each million of population, the smallpox deaths have annually averaged 158." "Or, compare two periods in Westphalia, during the years 1776-80, the smallpox death-rate was 2643; during the thirty-five years, 1816-50, it was only 114." "Or, taking two metropolitan cities, you find that, in Copenhagen for the half century 1751-1800, the smallpox death-rate was 3128, but for the next half century only 286; and still better, in Berlin, where for twenty-four years preceding the general use of vaccination, the smallpox death-rate had been 3422, for forty years subsequently it has been only 176. In other words, the fatality of smallpox, in Copenhagen, is but an eleventh of what it was; in Sweden, a little over a thirteenth; in Berlin, and in large parts of Austria, but a twentieth; in Westphalia, but a twenty-fifth. In the last-named instance there now die of smallpox but four persons, where formerly there died a hundred." (p. xxiii.) By reference to the second table, it will be seen that in a number of places observed, the death-rate varies amongst the vaccinated from an inappreciably small mortality, to $12\frac{1}{2}$ per cent.; that amongst the unprotected, it ranges from $14\frac{1}{2}$ to $53\frac{4}{5}$ per cent. These statistics show that the adoption of vaccination has been followed by a reduction of the smallpox mortality to a tenth and a twentieth of its former magnitude.

Approximate average, annual death-rate by smallpox per million of living population.

Terms of years respecting which particulars are given.	Territory.	Before introduction of vaccination.		After introduction of vaccination.	
		Before introduction of vaccination.	After introduction of vaccination.	Before introduction of vaccination.	After introduction of vaccination.
1777—1806, and 1807—1850.	Austria, Lower,	2,484	340		
1777—1806, and 1807—1850.	{ " Upper, and Saltsburg,	1,421	501		
1777—1806, and 1807—1850.	Styria,	1,052	446		
1777—1806, and 1807—1850.	Illyria,	518	244		
1777—1806, and 1807—1850.	Trieste,	14,046	182		
1777—1806, and 1807—1850.	Tyrol and Voralberg,	911	170		
1777—1806, and 1807—1850.	Bohemia,	2,174	215		
1777—1806, and 1807—1850.	Moravia,	5,402	255		
1777—1806, and 1807—1850.	Silesia (Austrian),	5,812	198		
1777—1806, and 1807—1850.	Gallicia,	1,194	676		
1787—1806, and 1807—1850.	Bukownia,	3,527	516		
	1817—1850. Dalmatia,	—	86		
	1817—1850. Lombardy,	—	87		
	1817—1850. Venice,	—	70		
	1831—1850. Military Frontier,	—	288		
1776—1780, and 1810—1850.	{ Prussia (Eastern Provinces),	3,321	556		
1780 and 1810—1850.	{ Prussia (Western Provinces),	2,272	356		
1780 and 1816—1850.	Posen,	1,911	743		
1776—1780, and 1810—1850.	Brandenburgh,	2,181	181		
1776—1780, and 1816—1850.	Westphalia,	2,643	114		
1776—1780, and 1816—1850.	Rhenish Provinces,	908	90		
1781—1805, and 1810—1850.	Berlin,	3,422	176		
1776—1780, and 1816—1850.	Saxony (Prussian),	719	170		
1780, and 1810—1850.	Pomerania,	1,744	130		
	1810—1850. Silesia, Prussian,	—	310		
1774—1801, and 1810—1850.	Sweden,	2,050	158		
1751—1800, and 1801—1850.	Copenhagen,	3,128	286		

Death-rate per 100 cases.

Places and times of observation.	Total No. of cases observed.	Death-rate per 100 cases.	
		Among the unprotected.	Among the vaccinated.
France, 1816—41 . . .	16,397	13 $\frac{1}{8}$	1
Quebec, 1819—20 . . .	?	27	1 $\frac{2}{3}$
Philadelphia, 1825 . . .	240	60	0
Canton Vaud, 1825—29 . . .	5,838	24	2 $\frac{1}{8}$
Darkehmen (Dürkheim's) } 1828—29	134	18 $\frac{4}{5}$	0
Verona, 1828—39 . . .	909	46 $\frac{2}{3}$	5 $\frac{2}{3}$
Milan, 1830—51 . . .	10,240	38 $\frac{1}{3}$	7 $\frac{2}{3}$
Breslau, 1831—33 . . .	220	53 $\frac{1}{3}$	2 $\frac{1}{3}$

Places and times of observation.	Total No. of cases observed.	Death-rate per 100 cases.	
		Among the un-protected.	Among the vaccinated.
Wurtemberg, 1831 $\frac{1}{2}$ —5 $\frac{1}{2}$. . .	1,442	27 $\frac{1}{3}$	7 $\frac{1}{5}$
Carniola, 1834—35 . . .	441	16 $\frac{1}{4}$	4 $\frac{2}{3}$
Vienna Hospital, 1834 . . .	360	51 $\frac{1}{4}$	12 $\frac{1}{2}$
Carinthia, 1834—35 . . .	1,626	14 $\frac{1}{2}$	$\frac{1}{2}$
Adriatic, 1835 . . .	1,102	15 $\frac{1}{2}$	2 $\frac{1}{4}$
Lower Austria, 1835 . . .	2,287	25 $\frac{1}{2}$	11 $\frac{1}{2}$
Bohemia, 1835—55 . . .	15,640	29 $\frac{1}{4}$	5 $\frac{1}{5}$
Gallicia, 1836 . . .	1,059	23 $\frac{1}{2}$	5 $\frac{1}{4}$
Dalmatia, 1836 . . .	723	19 $\frac{2}{5}$	8 $\frac{1}{4}$
London Smallpox Hospital, } 1836—56 . . . }	9,000	35	7
Vienna Hospital, 1837—56 . . .	6,213	30	5
Kiel, 1852—53 . . .	218	32	6
Wurtemberg, no date . . .	6,258	38 $\frac{9}{10}$	3 $\frac{1}{2}$
Malta, no date . . .	7,570	21.07	4.2
Epidemiological Society re- } turn, no date . . . }	4,624	19.7	2.9

In an important paper in the Transactions of the Medical and Chirurgical Society of London (vol. xxxv.), Dr. J. G. Balfour, Surgeon to Royal Military Hospital, Chelsea, shows that the smallpox mortality of the British navy has not reached a third, nor that of the British army a fourth of the London rate; and that in the experience of the Royal Military Asylum for 48 years (within which time 5,774 boys have been received for training), only four deaths by smallpox occurred, *and these all in non-vaccinated* boys, who were believed already to have suffered smallpox once before becoming inmates of the school. "And," in the words of the reviewer of the above "papers," "the combined weight of testimony from all sources of evidence is to show *that in the proportion as vaccination is general and efficient, so is the exclusion of smallpox from the community, and the mortality greatly lessened.*"*

From a paper on smallpox and vaccination, read before the Boston Sanitary Association by Robert Ware, M. D., and pre-

* Brit. and For. Med.-Chir. Rev., Oct. 1857.

sented to the Senate and House of Representatives of Massachusetts, we learn that in Boston, in 1721, the year in which inoculation was introduced, and when the population of Boston was only 11,000, there were 5,759 cases of smallpox, of which 844 were fatal. Thus it appears that over one-half the inhabitants had the disease, and one-thirteenth died of it.

In 1730 there were 4,000 cases and 200 deaths. In 1752, when the population was 15,684, the number of cases was 5,545 and the deaths 539. Again, in 1764, there were 5,646 cases; in 1776, 5,292; and in 1792, 8,346.

If we turn now to the period subsequent to the introduction of vaccination and take the fifteen years between 1815 and 1830, when vaccination was, in a measure, compulsory and the restrictive system of isolation in force, we find the mortality of smallpox to amount to only *fourteen* deaths. A still longer period, from 1811 to 1839, shows that only fifty-two deaths from this disease occurred.

Not only is it shown by the above statistics that the *mortality* of smallpox is diminished, but that the *frequency* of epidemics is also greatly reduced. In the report of the Epidemiological Society of London, prepared by Dr. Seaton, it is shown that "during the ninety-one years (1650-1741) previous to inoculation, there had been 65 distinct and well-marked epidemics, which is a ratio of 71.4 epidemics in one hundred years.

During sixty-three years (1741-1803) in which inoculation was practised, and that to a great extent, there were 53 distinct and well-marked epidemics, which is a ratio of 89 epidemics in one hundred years.

During the last fifty years, since vaccination has been practised and inoculation declared illegal, there have been 12 epidemics of smallpox, which is a ratio of 24 epidemics in one hundred years.

Whence it appears that smallpox was epidemic in London before inoculation as 42; during inoculation as 54; during vaccination as 14. (*Ibid.*, p. 35.)

In concluding this branch of the subject, your Committee would call your attention to the question addressed, in circular, to members of the medical profession in the United Kingdom, and elsewhere, by Mr. Simon, medical officer to the General Board of Health in London, and to the great unanimity in the affirmative by the eminent authorities to whom it was sent.

"Have you any doubt that successful vaccination confers on persons subject to its influence, a very large exemption from attacks of smallpox, and almost absolute security against death by that disease?"

Out of 542 persons to whom this question was addressed, including not only the most eminent of British and Continental practitioners, but also foreign governments, through their officials, but two dissenting answers were received; every other expressed confidence in the practice.

2. Is the protection permanent? or is it modified by any circumstance?

That the protective influence of vaccination is subject to modification, either from the length of time elapsed since the operation or from a greater intensity of the variolous infection overriding the protection during certain periods of life, is very generally believed. Dr. G. B. Wood* says: "It cannot now be denied that a single vaccination does not afford the permanent security it was supposed to do. Probably nearly one-half of those vaccinated successfully are liable to more or less effect from the variolous contagion; though it is asserted that when the operation is performed with four or more insertions instead of one, the proportion of the protection is much greater.† It is chiefly during the epidemic prevalence of variola that this disposition in vaccinated persons to be

* Practice of Medicine, vol. i. p. 410.

† Medico-Chirurgical Transactions, xxxvi. 388.

affected by the disease is observed. It has very seldom been noticed to any considerable extent at other times. Another interesting fact is, that children of eight years, or under, are rarely attacked, that from this time to the age of puberty cases begin to be more frequent, and that the greatest number occurs between the ages of fifteen and twenty-five. These two facts it is important to bear in mind. What can be the cause of the inefficiency of protection in certain cases? It may, the author thinks, be explained by recurrence to the facts stated above, namely, the greater tendency to varioloid during the epidemic prevalence of smallpox than at other times, and greater frequency between the ages of fifteen and twenty-five than at any other period of life. Thus the security afforded by the vaccine disease, or smallpox, occurring in seasons when no epidemic influence exists, may be effectual under similar circumstances, but may fail during an epidemic when other forces are added to that of the contagious cause. That persons are most liable to the affection between fifteen and twenty-five would seem to show that the changes which take place about the period of puberty, and continue in operation more or less until that of maturity, which may be roughly placed at twenty-five or thirty, are favorable to the development of variolous disease; and that a degree of protection, which might be sufficient either earlier or later in life, is insufficient then." In the report by Dr. F. W. Sargent of cases attended in the Philadelphia City Hospital in 1845-6, it is stated that of the cases of varioloid or smallpox after one vaccination, amounting to one hundred and thirty-six, more than twice as many occurred in the ten years from nineteen to twenty-nine inclusive, as in either of the ten years preceding or following those ages.*

In a paper by A. B. Steele, Esq., M. R. C. S.,† the following passage occurs. "The opinion so frequently expressed, that

* Am. Journ. Med. Sci., N. S., xvii. 372.

† Liverpool Med.-Chir. Journ., July, 1858.

the protection afforded by vaccination in many cases lasts for a certain period only in the life of the individual, is by no means of recent origin, for in 1809, Dr. Brown, of Musselburgh, published the opinion that the protective virtue of cowpox diminished as the time from vaccination increased. Dr. Copland, also, in 1823, arrived at a similar conclusion, from some very remarkable cases which came under his notice, and in the present day there are many authorities of great repute in favor of this view." Mr. Simon, in the work already quoted, states that in Paris nearly one-third of the whole deaths from smallpox occurred between the age of twenty and thirty, indicating, as he remarks, an appalling amount of post-vaccinal smallpox.

He further states that what chiefly attracted attention was that persons who had been vaccinated ten or fifteen years ago, and who during this interval had, perhaps, repeatedly resisted smallpox, would at length, in a certain proportion of their number, yield to the infection. This had most frequently happened during the times when smallpox was severely epidemic among the unvaccinated, and when large masses of persons with vaccination of many years, were exposed to the test of a strong epidemic influence. Under this ordeal, it became evident that, for some vaccinated persons the insusceptibility conferred by cowpox was not of life-long duration. And from a careful analysis of cases it was shown that this lessened security of certain vaccinated persons bore at least *some* proportion to the number of years which, in each case, had elapsed since vaccination, for there were not materials to prove any uniform rate of increase from year to year, and the increase, such as it was, apparently continued up to thirty years of age, after which period it seemed that the liability to contract smallpox underwent a continuous decline. Thus, Professor Heim, taking 1055 cases of modified or unmodified smallpox in vaccinated persons, distinguished them under thirty-five heads, corresponding severally to the thirty-five years which had elapsed since vaccination. When this is divided into three successive parts, one for the *first twelve*

years after vaccination, one for the next *seventeen*, and one for the *following six years*, it appears that the average number for each year is, in the first division, 12; in the second division, 48; in the third, 15. A calculation of similar materials made by Professor Retzius,* with respect to 961 cases in the Stockholm Hospital, gave the following series to express the average allotment of smallpox to each year of life in eleven successive quinquennials, up to the age of fifty-five: $3\frac{1}{5}$, $4\frac{2}{5}$, $13\frac{1}{5}$, $45\frac{2}{5}$, $51\frac{3}{5}$, 40.20, $17\frac{3}{5}$, $3\frac{4}{5}$, $2\frac{1}{5}$, 1.

Mr. Marson's petition, previously quoted, tends to establish the same result.† "But few patients," he says, "under ten years of age have been received with smallpox after vaccination. After ten years the number began to increase considerably, and the largest admitted are for the decennial period from the age of fifteen to twenty-five; and although progressively diminishing, they continue rather large up to thirty; and from thirty to thirty-five, they are nearly the same as from ten to fifteen; but, as in the unprotected, at this period of life the mortality is doubled, showing the cause to be probably as much or more depending on age and its concomitants, as on other circumstances. In still further advanced life, the rate of mortality will be seen to increase also, as in the unprotected state; but this tendency may be in a considerable degree counteracted, there is but little doubt, by giving more attention than has hitherto generally been given to the perfection of the process of vaccination." Thus, it appears that age exerts a modifying influence upon the protection of vaccination, by which, during certain years of life, it is lessened. Whether it depend upon decadence of that influence, upon original imperfect vaccination, or upon a greater susceptibility, it needs not now to inquire, the fact is sufficient for our present purpose. It is not improbable, also, that in addition to the influence of age, a greater susceptibility to the

* Gaz. Méd. de Paris, 1843.

† Blue Book, p. xxx.

variolous influence may be produced by any marked change in the habits of life of those exposed to it. Recruits and volunteers may in this manner be more *endangered* than in the pursuit of their ordinary vocations.

From what has been shown thus far, it is probably established that vaccination, if carefully performed, exerts a positive protecting influence in favor of those receiving it. That in countries where vaccination is general, the fatality of smallpox has under its influence declined to some small fraction of that which formerly prevailed, but that there is at least a doubt as to whether that protection is operative during the period of life when men are most useful, and whether, as they approach adult life, they do not partially or wholly recover that susceptibility to smallpox which vaccination had once extinguished in them? If a doubt upon this latter point exist in the minds of those to whom the health of our troops is intrusted, surely they have a right to the benefit of that doubt, and it becomes the duty of those in authority to provide the means of safety, and restore or furnish that immunity which the soldier has either lost or failed to receive.

3. *Is Revaccination a preventive of smallpox?*

The answer to this question is found in the rich statistical results, mostly from foreign sources, by which so large a reduction both of the mortality and the disease itself is shown as to leave no doubt of its efficacy. Your committee have drawn largely from the reports of revaccination of large masses of men in various military establishments, especially in Germany, collected by Mr. Simon. The earliest experience of this kind came from Wirtemberg. In 1829 the practice of revaccinating the troops of that kingdom was commenced, and its collective results for the next few years are recorded in the following table, showing an abstract of these results in relation to five years, terminating with June, 1836. The author calls attention to one great fact deducible from these ob-

servations. It is that "on the average of more than 14,000 experiments (an immense majority performed at ages between twenty and thirty years), 34 out of every 100 persons revaccinated developed the same sort of vesicle as would arise from a first insertion of vaccine lymph. And it is important to observe that this renewed susceptibility to cowpox did evidently not depend, so far as could be traced, on any original ineffectiveness of the former vaccination; for (as is expressly set forth in the second part of the table), among the 14,384 subjects of vaccination, there were 7,845 who presented strictly normal scars of previous vaccination. Yet nearly a third of this large number gave again exactly such local phenomena as arise in children when vaccinated for the first time. It does not follow from this, however, that every third man would have taken the smallpox if exposed to the contagion; but that they would have been *endangered* admits of no doubt."

	Total.	Ratio of success per 1,000 cases vaccinated.		
		Perfect success.	Modified success.	No success.
Vaccination of the Wirtemberg army in the five years 1831½-5½.	14,384	340.2	260.8	411.5

13,681 of the above mentioned 14,384 military vaccinations being classified according to the marks of previous vaccination or smallpox, the results were as under.

Degree of success of revaccination.	Of cases with normal cicatrices of vaccination there were 7,845, and among these the results per 1,000 were—	Of cases with defective cicatrices of vaccination there were 3,545, and among these the results per 1,000 were—	Of cases with no cicatrices of vaccination or smallpox, there were 2,025, and among these the results per 1,000 were—	Of cases bearing marks of previous smallpox, there were 266, and among these the results as per 1,000 were—
Perfect . .	310.4	280.7	337.3	319.5
Modified .	280.5	259	191.1	248.1
None . . .	409.2	460.4	471.6	432.3

11,565 of the same number being distributed according to age, the results were as follows:—

Degree of success of revaccination.	Under 20 years of age there were revaccinated 124 persons, and the results per 1,000 were—	Between 20 and 30 there were revaccinated 11,157 persons, and the results per 1,000 were—	Above 30 years of age there were revaccinated 284 persons, and the results as per 1,000 were—
Perfect . .	338.7	285.6	426.1
Modified .	322.6	259.2	207.7
None . . .	338.7	455.2	366.2

Inoculation of lymph (whether vaccine or variolous) is (says Mr. Simon), so to speak, a finer and more delicate test of susceptibility to the smallpox poison than is the breathing of an infected atmosphere; so that many persons, when the lymph of cowpox or smallpox is inserted in their skin, will give, locally at least, evidences of susceptibility, which no atmospheric infection would have elicited from them. And of this perhaps there can be no more ready illustration than the fact that *persons who bore marks of previous smallpox were, in at least equal proportion with previously vaccinated persons, capable of producing perfect vaccine vesicles*; and probably they too, if tested with variolous matter, would have shown at the inoculated part similar signs of susceptibility: whereas, notoriously of persons who have once had smallpox, not nearly one-third becomes afterwards capable of contracting smallpox by frequenting the neighborhood of the sick.

For this reason (greatly corroborated by what had already in every-day practice been observed of the immunity of once vaccinated persons), it was evidently impossible to argue that all who on revaccination yielded perfect vaccine vesicles would, on ordinary exposure to smallpox infection, have been infected with smallpox. Not that all, or nearly all, of them would have suffered, but that from among them more than from among other vaccinated persons the occasional sufferers by smallpox would have come. (p. 34.)

In the Prussian army in 1833 there were revaccinated between forty and fifty thousand adults, and in about 33 per cent. of the

entire number this revaccination took with perfect success. In a revaccination of Russian soldiers at Kasan, the rate of perfect success was $18\frac{3}{5}$ per cent. It was observed at the same time, that in 1,436 persons presenting marks of previous smallpox, perfect vaccine vesicles would arise just as often as on persons who had once been vaccinated!

“Of nearly 20,000 revaccinations practised in the Danish army in the four years 1843-5 and 1847, more than half were attended with perfect success, and more than a quarter with modified success.”

“By the earliest of these various independent observations it was put beyond question that the same lapse of time which renders some vaccinated persons again susceptible of smallpox, renders them also susceptible of cowpox. But it remains to be seen whether that second dose of the latter infection which it was the object of revaccination to introduce, would restore such persons, either permanently or for a long time, to the state of security from which they had declined; whether by successful revaccination their revived susceptibility to smallpox would be extinguished.” (*Ibid.*)

Now this is precisely the point to which this communication tends, and it seems to be conclusively settled by the experience of the Prussian and Wirtemberg army revaccinations, which are selected from amongst a number of others in consequence of their extent and completeness.

In proof of the practical value of revaccination, Mr. Simon states, on the authority of Professor Heim, that in Wirtemberg—

“During the five years, 1833-7, though smallpox infection had been sixteen times imported into different regiments of the army, there had ensued among the 14,384 revaccinated soldiers only—in the person of one whose revaccination two years before had been followed by ‘modified success’—a single instance of varioloid.” (p. 35.)

“In Prussia just as in Wirtemberg, the practice of revaccina-

tion grew out of the knowledge that smallpox would ultimately attack a certain proportion of those who had been vaccinated only in infancy. This knowledge, too, had been dearly purchased in the Prussian army; for during the ten years preceding 1831, cases of post-vaccinal smallpox were increasing in number and fatality; attacks were counted annually by many hundreds; and within the three years 1831-3 there had occurred no fewer than 312 deaths by smallpox.

"For the last twenty years the Prussian army has represented an almost entirely revaccinated population, and what has been the contrast? 104 annual deaths by smallpox was the last experience of the former system; 2 annual deaths by smallpox has been the average for the revaccinated army. Analyzing, moreover, the 40 fatal cases of smallpox which the last 20 years have occurred in the Prussian army, we find that only 4 of the number were of persons who (it is said) were successfully revaccinated."

"From 1843 revaccination has been compulsory in the Bavarian army; and from that date to the present time (1857) neither a single death by smallpox nor even a single case of unmodified smallpox has occurred in that population."*

"For the last 21 years revaccination has been general in the Danish army, and for the last 13 years in the Danish navy; and these two populations have almost entirely escaped contagion during several epidemics of smallpox."†

In Sweden the practice is similar, and the results equally satisfactory. In the Swedish army 1,944 revaccinations were performed in 1852, of which 644, or 33.11 per cent., were successful.

In the Baden army revaccination was introduced in 1840, and has since been effected with the greatest punctuality and exactness, with the exception of the years 1848-9, '50, when, in con-

* Royal Ministry of War.

† Board of Health.

sequence of political events it lapsed. The number of men attacked in twelve years by variola and varioloid before the introduction of revaccination was 169, whilst the corresponding number after its introduction for a like period was 52 only, of whom only 12 had been operated on with success, the remainder having been revaccinated without result, or else not at all.

Dr. T. Graham Balfour, Head of the Statistical Branch of the Medical Bureau of the British Army, in his first general report, presented to Parliament at its last session, has given an interesting statement of the results of the very general vaccination and revaccination in the British Army during the years 1858-9. We quote the following statements and statistics from Dr. Balfour's report:—

“In 1858, in consequence of a number of cases of smallpox having occurred in the army, particularly in India, among persons who had, to all appearance, been previously satisfactorily vaccinated, a departmental order was issued that in future every recruit should, on joining his regiment, be vaccinated, even if he should be found to have marks of smallpox or of previous vaccination, and a monthly return of the results to be forwarded to the Director-General.

“Under these orders, also, a number of soldiers in whom the marks of vaccination were not deemed satisfactory, were vaccinated, and the results were kept separate from those of the recruits.

“As the returns began to be furnished in October, 1858, we have included the results of the last three months of that year with those of 1859, with a view to render available all the information upon this important subject.

“The following table shows the degree of success which attended the operation in 1000 cases in each of four different categories, together with the general result upon all the men vaccinated:”—

ARMY EXCLUSIVE OF MILITIA.	Total number vac- cinated.	RESULTS.	In those who bore marks of previous smallpox.	In those who bore good marks of previous vacci- nation.	In those who bore doubtful marks of previous vaccina- tion.	In those who bore no marks of pre- vious vaccination or smallpox.	TOTAL.
Soldiers not recruits	4,403	{ A perfect vac- cine pustule A modified ditto A failure in Total	414.50 200.74 384.76 1000	423.50 179.69 396.81 1000	294.12 363.44 342.44 1000	488.96 167.19 343.85 1000	413.13 201.23 385.64 1000
Recruits	21,686	{ A perfect vac- cine pustule A modified ditto A failure in Total	350.06 187.09 462.85 1000	388.71 221.16 390.13 1000	427.61 251.93 320.46 1000	536.64 206.06 257.30 1000	398.37 217.33 384.30 1000

EMBODIED MILITIA.	Total number vac- cinated.	RESULTS.	In those who bore marks of previous smallpox.	In those who bore good marks of previous vacci- nation.	In those who bore doubtful marks of previous vaccina- tion.	In those who bore no marks of pre- vious vaccination or smallpox.	TOTAL.
Soldiers not recruits	1,598	{ A perfect vac- cine pustule A modified ditto A failure in Total	327.07 191.73 481.20 1000	294.57 236.44 468.99 1000	612.12 193.94 193.94 1000	451.85 192.59 355.56 1000	340.06 220.90 433.04 1000
Recruits	4,823	{ A perfect vac- cine pustule A modified ditto A failure in Total	351.14 212.28 436.58 1000	295.00 248.59 256.41 1000	415.18 174.11 410.71 1000	585.03 105.45 309.52 1000	326.97 230.77 442.26 1000

The following table shows the result in Wirtemberg, Bava-
rian, and Prussian armies, compared with the preceding:—

	Number of revaccinations.	RESULTS IN 1000 REVACCINATIONS.		
		Perfect success.	Modified success.	Failures.
Wirtemberg	14,384	340.2	248.3	411.5
Bavarian	46,023	347.3	220.6	432.0
Prussian (1836-40) . . .	216,426	456.3	215.0	328.7
British (recruits)	21,686	346.1	220.9	433.0

In our own army the statistics are meagre, those of Dr. Forry being the only results accessible to the committee, and these merely prove the susceptibility to revaccination. Still, they are valuable as affording evidence of a "condition of danger" in those in whom the operation was successful. The data constituting the results of Dr. Forry's paper* were furnished at Fort Wood, New York harbor, then used as a depot for recruits. Of 686 recruits vaccinated 560 had been previously vaccinated, 74 had had smallpox naturally, and 52 had not been inoculated either with the variolous or vaccine virus, and had not had the disease naturally. Of the 560 previously vaccinated 381 exhibited good cicatrices; in 134 they were indistinct or imperfectly developed; and in 45 no cicatrices were visible. Of the 560 previously vaccinated 196 took the disease on revaccination, including fifty-five which from the irregular progress of the vesicle were regarded as affording a partial protection from the smallpox. Of these 196, 109 had been previously vaccinated before the age of five years; 48 between the ages of five and ten; and 39 subsequently to the latter age. To determine, then, the period during which vaccination gives a "charmed life," it is necessary to institute a comparison between these and the whole number vaccinated. Thus of the 560 previously vaccinated, 316 took place before the age of five years; 133 between the ages of five and ten years; and 111 after the latter period. Hence it follows, though not as an exact result, that as the ages of the great majority of the men ranged from twenty to thirty-three (the average being twenty-five years), and as the ratio of successful revaccination is very nearly the same after each interval of age (being about one-third), the limit of the protective powers of cowpox is not restricted to any precise number of years. These relative

* Amer. Journ. Med. Sci., April, 1842.

ratios among the 560 previously vaccinated may be thus represented:—

	Under 5.	5 and under 10.	10 and upward.	Total.
Number of vaccinations	315	133	111	560
Number of successful revaccinations	109	48	39	196

The only statistics of revaccination of the present army we have been able to obtain are the following, kindly furnished by Dr. S. O. Vanderpoel, Surgeon-General of New York, from the first returns made to him in accordance with a general order:—

Total number of recruits examined with reference to vaccination . .	9,548
Number of persons bearing the marks of previous vaccination . .	7,765
Total number vaccinated or revaccinated	8,095
“ “ who were found to be susceptible	2,292
Number of the susceptible persons who had marks of previous vaccination	1,338

This communication has shown, we trust, 1st. That primary vaccination is a positive protection, within certain limits, against smallpox. 2d. That there is a period of life when that influence declines, and that the history of epidemics teaches that smallpox will attack a variable proportion of the vaccinated if exposed to its influence. 3d. That the mere *possibility* of such a decline renders re-protection necessary. 4th. That in revaccination we have an almost infallible restorer of that protection and preventive of the spread of variolous epidemics. Hence, that revaccination in all bodies exposed to variolous contagion is *imperatively* demanded. 5. That the operations of vaccination and revaccination are unattended with danger to those subjected to them. The committee would therefore earnestly recommend that the Sanitary Commission make such representation to the proper authorities as will secure the revaccination of all soldiers who cannot prove its performance upon them within the previous five years; and that arrangements be made by which good vaccine virus may be distributed by their agents to the medical officers.

FRANCIS G. SMITH, M.D., *Ch'n.*
ALFRED STILLÉ, M.D.

APPENDIX.

SIGNS OF SUCCESSFUL VACCINATION AND OF SUCCESSFUL REVACCINATION.

(GREGORY, revised by CEELY and MARSON.)*

(A.) "When Vaccination has been successfully performed the puncture may be felt elevated on the second or third day, and soon afterwards, if examined with a magnifying glass, appears surrounded by a slight redness. On the fifth or sixth day a distinct vesicle is formed, having an elevated edge and depressed centre. On the eighth day it appears distended with a clear lymph. The vesicle, on this, its day of greatest perfection, is circular and pearl-colored; its margin is turgid, firm, shining, and wheel-shaped. Late on the seventh, or early on the eighth day, an inflamed ring or areola begins to form around the base of the vesicle, and, with it, continues to increase during the two following days. This areola is of a circular form, and its diameter extends from one to three inches. When at its height, on the ninth or tenth day, there is often considerable hardness and swelling of the subjacent cellular membrane. On the tenth or eleventh day the areola begins to subside, leaving, as it fades, two or three concentric circles of redness. The vesicle now begins to dry in the centre, and acquires there a brownish color. The lymph which remains becomes opaque, and gradually concretes; so that about the fourteenth or fifteenth day the vesicle is converted into a hard round scab of a reddish-brown color. This scab contracts, dries, blackens, and, about the twenty-first day falls off. It leaves a cicatrix which commonly is permanent in after life, circular, somewhat depressed, dotted or indented with minute pits, and, in some instances radiated. The above described local changes, while in active progress, are attended by feverishness; first, from the fifth to the seventh day, so slightly that often the fact passes unobserved; and again more considerably during those days when the areola is about its height; the patient now being restless and hot, with more or less disturbance of stomach and bowels. About the same time, especially if the weather be hot, children of full habit not unfrequently

* Second Report of the Medical Officer of the Privy Council, 1859. (Blue Book.) London.

show on the extremities, and less copiously on the trunk, a lichenous, roseolar or vesicular eruption, which commonly continues for about a week. When vaccination is performed on such adults or adolescents as have not previously been vaccinated, and likewise when lymph is employed which has recently been derived from the cow, the resulting phenomena, as compared with the preceding description, are somewhat retarded in their course; and the areola is apt to be much more diffuse. There is also more feverishness; but eruption is less frequently seen."

(B.) "When persons who have once been efficiently vaccinated are, some years afterwards, revaccinated with effective lymph, there sometimes result vesicles, which, as regards their course and that of the attendant areolæ, cannot be distinguished from the perfect results of primary vaccination. But far more usually the results are more or less modified by the influence of such previous vaccination. Often no true vesicles form, but merely papular elevations surrounded by areolæ; and these results having attained their maximum on or before the fifth day, afterwards quickly decline. Or if vesicles form, their shape is apt to vary from that of the regular vesicle, and their course to be more rapid, so that their maturity is reached on or before the sixth day, their areolæ decline on or before the eighth day, and their scabbing begins correspondingly early. In either case the areolæ tend to diffuse themselves more widely and less regularly, and with more affection of the cellular membrane, than in primary vaccination; and the local changes are accompanied by much itching, often by some irritation of the axillary glands, and in some cases on the fourth or fifth day by considerable febrile disturbance."

METHOD OF PRESERVING VACCINE LYMPH.

BY DR. HUSBAND, OF EDINBURGH.*

The following method of preserving lymph in capillary glass tubes has been found entirely successful. Lymph has been used after being kept for several years, with satisfactory results.

The tube employed is simple, straight, cylindrical, open at both ends, and of such dimensions as to fulfil the following conditions, upon which it will be found that its peculiar value, as a means for preserving lymph for future every-day use, essentially depends. It must be—

1. In the first place, of such tenuity that it can be sealed instantaneously at the flame of a candle.

* Second Report of the Medical Officer of the Privy Council, 1859. (Blue Book.) London.

2. In the second place, large enough to contain as much lymph as is sufficient for one vaccination.

3. In the third place, long enough to admit of both ends being sealed hermetically without subjecting the charge to the heat of the flame.

4. And, in the fourth place, of such strength as not to break easily in the mere handling.

The following is the mean of several measurements which I have made of tubes, differing somewhat in size, but all of them capable of containing a sufficient charge of lymph, and of being sealed instantaneously at the flame of a candle, without subjecting the contained charge to the heat, and also strong enough to bear all necessary manipulations without breaking:—

Average length $2\frac{3}{4}$ to 3 inches.

Diameter $\frac{1}{8}$ of an inch.

Thickness of wall $\frac{1}{16}$ of an inch.

Calibre.

The vesicles having been opened with a lancet in the usual way, the tube held in a position more or less inclined to the horizontal, is charged by applying one end of it (the straight end, if they be not both straight) to the exuding lymph which enters immediately by the force of capillary attraction. Allow as much to enter as will occupy from about one-seventh to one-half the length of the tube, according as its capacity is greater or less. As a general rule each tube should not be charged with more than will suffice for one vaccination.

It is now to be sealed in one or other of the following ways:—

Either, 1st, make the lymph gravitate towards the middle by holding the tube vertically and giving it a few slight shocks by striking the wrist on the arm or table; then seal the end by which the lymph entered by applying it to the surface of the flame of a candle, or any similar flame. It melts over and is sealed immediately.

Proceed with the other end in the same way, but first plunge it suddenly, say half an inch into the flame, and as quickly withdraw it till it touches the surface, and hold it there till it too melts over. It is necessary to plunge it first into the flame, for this reason, that if it be at once applied to the external surface of the flame it melts over, no doubt, and is sealed; but before you have time to complete the process, and while the glass is still soft, the contained air expands with the heat, and forms a minute bulb, which either gives way on the instant, rendering it necessary for you to break off the end and commence anew, or, what is still worse, remains entire for the time, only to break afterwards, in consequence of its extreme tenuity of wall, by the lightest touch. Mr. Ceely has suggested that while this

precaution is necessary for the reason stated it serves also to expel a portion of air, and so leave less air to be sealed up along with the fluid lymph.

Or else, 2dly, the charge having entered, hold the tube with the finger and thumb, covering the inner extremity of the column of lymph, and protecting it from the heat, and draw nearly the whole of the empty portion through the flame so as to rarefy the contained air, and in withdrawing it seal the further extremity. The column now passes quickly along towards the middle of the tube as the contained air cools, and you complete the process by sealing lastly the orifice by which it entered.

It should be observed, that in no case is a tube to be laid down until the lymph has been made to pass towards the middle of it, for the fluid concretes quickly about the orifice, and you cannot afterwards detach it without difficulty; but if it be at once made to pass away from the orifice by holding the tube vertically, you may lay the charge down and take half a dozen or more in the same way before sealing them; only if you delay the sealing process too long, more than five or ten minutes perhaps (a delay which need never happen) the lymph within the tube is apt, from evaporation, to become adherent, especially if it be more than ordinarily viscid, and it cannot afterwards be blown out when you come to use it.

If the lymph do not exude freely, the tube may require to be drawn several times more or less obliquely across the surface of the vesicle or cluster of vesicles until a sufficient charge has entered; but generally if the exudation be copious, and a drop of some size has formed before you begin to take your supply, the orifice of the tube need not, indeed, ought not, to touch the surface, but is merely to be dipped into the clear fluid; and one may commonly in this manner from one arm charge five or six tubes in almost as many seconds with perfectly pure and limpid lymph, which shall contain neither epithelial scales nor pus globules nor blood disks, and therefore be, so far, in the best possible condition for preservation.

In order to obtain the lymph from a tube for the purpose of vaccinating the sealed ends are broken off, and the contents blown out gently on the point of the lancet or vaccinator.

The tubes may be easily and safely sent by post in the following manner:—

A flat piece of soft fir, about three inches and a half long, an inch and a half wide, and one-sixth of an inch thick, has a narrow and shallow groove made in it about a quarter of an inch wide, into which the charged tubes, two or more of them, are placed, with perhaps a few filaments of cotton beside them to prevent motion. Another piece of wood of the same size, but

which need not be quite so thick, is then laid above the groove and its contents, and the two pieces are joined in any way that is thought most convenient, by being tied or pinned together.

NEW MODE OF PRESERVING VACCINE VIRUS.

By Dr. COLLINS.*

Having experienced much trouble, particularly of late, in keeping a reliable supply of vaccine virus, for public vaccinations, I was glad to meet with any suggestions which would aid me in accomplishing this very desirable object. I immediately made some experiments, which have convinced me that, by the use of glycerine, we can probably preserve vaccine virus for a great length of time, and that when we desire it for more immediate use, this liquid is by far the best solvent for the solid matter that we possess. It saves us both time and trouble, and enables us to use the matter with much greater economy, which is of importance when our stock happens to be small. I think that no one who has once used glycerine for this purpose, would desire to use anything else.

In my first experiment, I pulverized about one-eighth of an ordinary scab, upon a glass plate, and moistened it with a small drop of glycerine. It is better that the matter be pulverized, as it otherwise dissolves very slowly. The quantity thus prepared served for my vaccinations for several days, amounting in all to twenty-four, among which there were but two failures—a success which I have rarely attained when using water as the solvent. There was, of course, no drying up of the matter after the solution, requiring renewed applications of the solvent, and so long as any remained upon the plate it was ready for immediate use.

I next pulverized another one-eighth of a scab, and dissolved it in about two drops of glycerine, placed at the bottom of a very small phial. From this I filled, by suction with the mouth, four of the usual capillary glass vaccine tubes, and sealed them hermetically—using for this purpose but about one-half the two drops. From one of these tubes I have since vaccinated three children successfully, using less than one-half its contents. The other three tubes I shall keep for some time, to see if age will in any degree impair its quality.

I see no reason why, when thus dissolved in glycerine, and hermetically sealed in glass tubes, it should not retain its virtue for a great length of time. The antiseptic qualities of the glycerine, I should judge, would render it less liable to change

* Boston Medical and Surgical Journal, 1858.

than is the pure vaccine lymph when treated in the same way, which we know can thus be kept for many months.

If I am correct in the foregoing conclusions, which a little time will determine, the preservation of vaccine virus, and the distribution of it, when desired, to distant sections of the country, will become an exceedingly simple and easy affair. A single scab, prepared as above, would be sufficient to fill some fifty tubes, each of which would be capable of vaccinating ten or more persons.

I would suggest that the glass tubes, for this purpose, should be drawn with a little larger bore than those in use for the pure lymph, both for the convenience of filling, and that the solution may be used in a little more concentrated form than is practicable with the very fine capillary tubes which answer well for the latter purpose.

HOW TO VACCINATE.

By HENRY A. MARTIN, M. D., OF ROXBURY, MASS.*

"Make, with the point of a clean lancet, some groups of transverse scratches, or, rather, very delicate incisions. The number of these will vary according as few or many vesicles are considered necessary. The length of the individual scratches will determine, of course, the size of the resulting vesicle, and, to some degree, the soreness of the arm.

The incisions should be so slight as barely to result in the faintest possible exudation of blood, and *that* only after the lapse of a second or two; but, if a greater flow of blood *does* ensue, the operation will be no less certain in its results, although a little neatness will have been needlessly sacrificed. To that group of scratches from which blood first exudes, the charged point of a quill is to be applied; the lymph thereon will be immediately absorbed; the particle of blood with the lymph in solution, is to be then taken up on the point of the quill, applied to, smeared over, and pressed into the other scratches, in succession, two or three times.

When the dissolved scab or fluid lymph is employed, it is to be applied on the point of the lancet, precisely as the dissolved lymph on the point of the quill."

Vaccine lymph on a quill-point is best introduced by inserting it about a quarter of an inch into a flat, superficial valvular incision under the cuticle, made by a narrow-bladed lancet in the skin over the attachment of the left deltoid muscle, keeping the quill-point there for a minute or two, wiping it off on the edges of the cut as it is withdrawn, and avoiding, in the whole operation, the effusion of blood as far as possible.

* Boston Medical and Surgical Journal, April, 1860.